Analysis of Animal Feed Products Sold in Connecticut During 2022

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INTRODUCTION

The Animal Feed Regulatory Program Standards (AFRPS) were designed to institute a uniform framework for the establishment of animal feed monitoring programs at the state level. In Connecticut, The Agricultural Commodities Division of The Department of Agriculture (DoAg) is responsible for regulation and inspection of animal feeding products and pet foods. Products collected by Department of Agriculture agricultural commodity inspectors are delivered to the Department of Analytical Chemistry (DAC) at The Connecticut Agricultural Experiment Station (CAES) for analysis to ensure compliance with state and federal regulations. The laboratories in the Department of Analytical chemistry are ISO 17025:2017 accredited to perform percent crude fat, percent crude protein, pesticides, and Aflatoxin analysis in animal feeds. This accreditation ensures accurate results with appropriate quality control samples and record keeping.

Aflatoxins are carcinogenic toxins produced by the fungus *Aspergillus flavus*. *A. flavus* mold can grow on cereal grains and legumes such as corn or peanuts while in storage. In December 2020 there were 28 out of state fatalities linked to dog food contaminated with Aflatoxins (5). This event triggered an FDA recall of the associated animal feed batches. A similar event occurred in September of 2020, with a recall extending to animal feeds that used the same corn grain. There are four main Aflatoxins B1, B2, G1 and G2. Aflatoxin B1 is predominate and considered the most toxic. If ingested, B1 and B2 can be transformed into Aflatoxin metabolites M1 and M2 respectively, which can be transferred into milk. The toxins can also enter the human food chain both by direct consumption of the product, or through livestock that have eaten the contaminated product. Currently, the FDA has a set action level for combined Aflatoxins (B1+B2+G1+G2) ranging from 100-300 µg/kg for beef cattle, swine, or poultry fed animal feed containing corn, peanut, or cottonseed ingredients. A lower action level of 20 µg/kg is in place for animal feeds intended for dairy animals, immature animals, and pets (4).

Deoxynivalenol is a toxin produced by different Fusarium molds that can grow on wheat, corn, oats, barley, and other grains. The FDA has set advisory levels for Deoxynivalenol present in grains and grain by-products used to produce animal feeds. ranging from 5 ppm to 10 ppm for cattle, 10 ppm for chickens, and 5 ppm swine and other animals (6).

Fumonisin is a toxin produced by some strains of Fusarium that can grow on corn and sometimes wheat. The FDA has established guidelines for the total amount of Fumonisin (Fumonisin FB1 + FB2 + FB3) for corn intended for use in animal feeds. Limits range from 5 ppm to 60 ppm, depending on the

livestock type and age consuming the feed (7).

METHODS

In calendar year 2022, The Department of Analytical Chemistry at The Connecticut Agricultural Experiment Station analyzed 47 animal feed products for label guarantees, 74 products for the presence of Aflatoxins, 8 products for deoxynivalenol, 4 for Fumonisin, 76 samples for Macro Minerals, 70 samples of dog food for copper analysis, 18 samples for toxic metals analysis, and 4 samples for pesticides analysis that were for sale in Connecticut. Animal feeds were collected by Department of Agriculture's Commodity Inspectors at manufacturing facilities, wholesale dealers, and retail locations. Samples were drawn from bulk storage/delivery containers, as well as from retail bags, boxes, and cans.

After delivery to The Connecticut Agricultural Experiment Station, the animal feed products were sub-sampled and prepared for analysis. The samples were analyzed for protein, fat, and fiber based on modified methods described in Official Methods of Analysis (2).

Aflatoxins were extracted using 80% acetonitrile in water, followed by solid phase extraction with cartridges specific for Aflatoxin B1, B2, G1, and G2. Analytes are then eluted using methanol. Aflatoxin analysis was performed using liquid chromatography with high resolution mass spectroscopy (LC-HRMS). The LC-HRMS detection limit for individual Aflatoxin compounds was 1 µg/kg.

Deoxynivalenol and Fumonisin were extracted using a modified QuEChERS (quick, easy, cheap, effective, rugged, and safe) method, using 10% formic acid in acetonitrile as the extraction solvent. Sample extracts were filtered then analyzed using a liquid chromatograph coupled to a high-resolution mass spectrometer (LC-HRMS).

Pesticide residues were extracted using modified QuEChERS method, using acetonitrile as the extraction solvent, followed by cleanup. Sample extracts were analyzed using both LC-HRMS and a gas chromatograph coupled to a tandem mass spectrometer (GC-MS/MS).

Samples analyzed for macro nutrients and toxic elements were prepared by closed vessel microwave acid digestion with analysis using Inductively Couples Plasma Optical Emission Spectroscopy (ICP-OES) and Inductively Coupled Plasma Mass Spectroscopy (ICP-MS).

All results are submitted to the Department of Agriculture for possible regulatory response.

RESULTS AND DISCUSSION

Label Guarantees

Table 1 shows the results for the analysis of crude protein, crude fat, and crude fiber. The label guaranteed nutrient value is denoted as (G) and the laboratory determined nutrient value is denoted as (R). Deficiencies and excesses of a guaranteed nutrient are expressed in red.
The number of samples deemed unsatisfactory in one or more macronutrients was 5 out of 47 samples processed (10.6%). In one of the 5 samples, mislabeling occurred for claimed % crude fiber of 1% when analysis determined a value of 1.6% (Table 1). In a second sample, mislabeling occurred for claimed % crude fat of 0.75% when analysis determined a value of 2.9%. The third mislabeling occurred for a sample with % crude fiber of 2.5% when analysis determined a value of 3.8%. The fourth deficiency occurred for a sample claiming % crude fiber at 1.5% when analysis determined

a value of 2.2%. And the firth mislabeling occurred for a sample claiming % crude protein of 18% when analysis determined a value of 13.4% (Table 1).
All protein samples are analyzed in duplicate. However, there are no duplicates for Fat and Fiber. The results for protein reflect the average of duplicates. In Table 1, ND indicates that the required analysis was not performed because the method was being developed.

Aflatoxins, Deoxynivalenol, and Fumonisin

Animal feed products analyzed for Aflatoxins during 2022 are shown in Table 2. All 74 animal feed samples tested for Aflatoxins had a sum of Aflatoxins B1, B2, G1, and G2 that was below the limit of detection.
Additionally, all 4 feed samples tested for Fumonisin (Table 2) contained a sum of Fumonisin FB1, FB2, and FB3 that was below the limit of detection. However, of the 8 feed samples tested for the presence of Deoxynivalenol (Table 3), 6 (FED23-03, FED23-12, FED23-013, FED23-014, FED23-016, and FED23-018) contained an amount above the reporting limit of 500 ug/kg but below a guidance level of 5000 ug/kg.

Pesticides

For the 2022 calendar year, only 4 animal feed samples were analyzed for the presence of pesticide residues (Table 5). None of the tested samples contained pesticide residues above the reporting limit of 0.01 mg/kg.

Elemental Analysis

Table 4 shows the results of the toxic element analysis. Table 5 shows the results of the Macro Minerals Analysis. There were 3 deficiencies for macro mineral label claims. The first deficiency was in sample FED23-04 which claimed a minimum phosphorus level of 0.45 % when analysis determined a value of 0.36 % (Table 5). The second deficiency was in sample FED23-06 which claimed a maximum calcium level of 0.75 % when analysis determined a value of 1.35 % (Table 5). The third deficiency was in sample FED23-08 which claimed a maximum calcium level of 1.05 % when analysis determined a value of 1.48 % (Table 5). Table 6 shows the results of the Copper analysis in dog feeds.

Animal feed products are reported to be unsatisfactory based on guidelines established by the Association of American Feed Control Officials (AAFCO) (3). All samples were analyzed in duplicate for elemental analysis.

Table 1. A comparison between label guarantees (G) and analytical results (R) for animal feeds received from the Connecticut Department of Agriculture for the calendar year 2022. Values in red indicate results that did not pass.

		Protein %		Crude Fat %		Crude Fiber %	
Sample ID	**Description**	**G**	**R**	**G**	**R**	**G**	**R**
FED22-137	Dog Feed	30	31.2	14	21.6	3	2.5
FED22-140	Dog Feed	5	6.9	1	2.6	1	0.3
FED22-143	Dog Feed	8	9.4	7	10.9	1.4	1.6
FED22-146	Dog Feed	8	9.7	3	5.2	1	0.5
FED22-149	Dog Feed	9	11.3	5	5.8	2	0.2
FED22-152	Dog Feed	9	10.3	6	9.8	1.5	1.2
FED22-155	Dog Feed	9	10.4	7	7.0	1	1.6
FED22-158	Dog Feed	7.5	9.1	3.5	5.9	1	1.2
FED22-161	Dog Feed	8	9.7	3	3.6	2	1.1
FED22-164	Dog Feed	9.5	12.0	6	7.1	1.5	0.3
FED22-167	Dog Feed	9.5	12.0	6	8.9	0.75	2.9
FED22-170	Dog Feed	9	11.2	5	7.6	1.4	1.0
FED22-173	Dog Feed	5	6	3	3.7	2.5	3.8
FED22-176	Dog Feed	8	9.8	7	7.9	1.5	2.2

Table 1. A comparison between label guarantees (G) and analytical results (R) for animal feeds received from the Connecticut Department of Agriculture for the calendar year 2022, continued. Values in red indicate results that did not pass.

		Protein %		Crude Fat %		Crude Fiber %	
Sample ID	**Description**	**G**	**R**	**G**	**R**	**G**	**R**
FED22-179	Dog Feed	26	27.6	16	ND	3	2.4
FED22-182	Dog Feed	25	27.8	12	11.4	4	2.7
FED22-185	Dog Feed	28	31.4	18	16.3	5	2.2
FED22-188	Dog Feed	20	21.5	10	10.9	8.5	3.8
FED22-191	Dog Feed	26	31.4	14	ND	4.5	3.4
FED22-194	Dog Feed	8	8.4	2	2.3	2	0.2
FED22-196	Dog Feed	6	7.5	2	ND	1	0.5
FED22-198	Dog Feed	4.6	6.1	2	2.7	1.5	0.9
FED22-200	Dog Feed	5	7.3	4	6.5	1.5	0.2
FED22-202	Dog Feed	38	39.3	29	31.3	6	4.3
FED23-05	Poultry Feed	18	13.4	3.5	5.7	3.5	2.5
FED23-07	Poultry Feed	20	22.1	3.5	3.4	3.5	2.4
FED23-09	Poultry Feed	18	17.4	3.5	7.6	3.5	3.0
FED23-020	Dog Feed	8	9.3	2	2.9	2	0.30
FED23-022	Dog Feed	10	12.7	7.5	8.8	1.5	0.76
FED23-024	Dog Feed	8	9.1	5	6.6	1.4	1.2

Table 1. A comparison between label guarantees (G) and analytical results (R) for animal feeds received from the Connecticut Department of Agriculture for the calendar year 2022, continued. Values in red indicate results that did not pass.

		Protein %		Crude Fat %		Crude Fiber %	
Sample ID	**Description**	**G**	**R**	G	**R**	**G**	**R**
FED23-026	Dog Feed	9.5	10.5	8	9	2	1.7
FED23-028	Dog Feed	8	10.7	3.5	5.8	1	1.1
FED23-030	Dog Feed	7	8.2	3	5.0	3	1.5
FED23-032	Dog Feed	8	9.5	5	6.4	1.5	0.32
FED23-034	Dog Feed	8	11.3	6	8.4	1.5	0.91
FED23-036	Dog Feed	9	12.9	7	9.9	1.4	0.64
FED23-038	Dog Feed	9.5	10.6	8.5	11.1	3	0.63
FED23-040	Dog Feed	30	34.6	28	25.9	5	2.8
FED23-042	Dog Feed	27	29.2	17	14.6	6	3.7
FED23-044	Dog Feed	31	28.6	20	16.7	3	2.2
FED23-046	Dog Feed	26	26.6	14	13.5	3	2.6
FED23-048	Dog Feed	38	40.8	17	15.9	4	2.9
FED23-050	Dog Feed	22	26.1	16	13.5	3.5	1.4
FED23-052	Dog Feed	38	41.1	24	30.5	15	11.7
FED23-054	Dog Feed	23	28.4	10	13.0	5	3.8
FED23-056	Dog Feed	28	30.4	18	17.2	3.6	1.7
FED23-058	Dog Feed	25	29.7	15	15.4	3	3.2

Table 2. List of animal feeds tested for Aflatoxins B1, B2, G1, and G2 in the year 2022.

Sample ID	Description
FED22-205-1	Soybean Meal
FED22-205-2	Soybeans
FED22-205-3	Cracked Corn
FED22-206	Pig Feed
FED22-207-1	Soybean Meal
FED22-207-2	Soybeans
FED22-207-3	Cracked Corn
FED22-208	Sheep Feed
FED22-210	Bovine Feed
FED22-210-1	Corn
FED22-212	Bovine Feed
FED22-212-1	Corn
FED22-234	Bovine Feed
FED22-234-1	Corn
FED22-236	Other Ruminant Feed
FED22-236-1	Corn
FED22-238	Sheep Feed
FED22-238-1	Corn
FED22-240	Pig Feed
FED22-240-1	Corn
FED22-242	Poultry Feed
FED22-242-1	Corn
FED22-244	Poultry Feed
FED22-244-1	Corn
FED22-246	Poultry Feed
FED22-246-1	Corn
FED22-248	Poultry Feed
FED22-248-1	Corn
FED22-250	Pig Feed
FED22-250-1	Corn
FED22-252	Poultry Feed
FED22-252-1	Corn
FED22-254	Poultry Feed
FED22-254-1	Corn

Table 2. List of animal feeds tested for Aflatoxins B1, B2, G1, and G2 in the year 2022, continued.

Sample ID	Description
FED22-256	Pig Feed
FED22-256-1	Corn
FED22-258	Pig Feed
FED22-258-1	Cracked Corn
FED22-258-2	Soybean Meal
FED22-258-3	Soybeans
FED22-260	Bovine Feed
FED22-260-1	Cracked Corn
FED22-260-2	Soybean Meal
FED22-260-3	Soybeans
FED22-262	Pig Feed
FED22-262-1	Cracked Corn
FED22-262-2	Soybean Meal
FED22-262-3	Soybeans
FED22-264	Sheep Feed
FED22-264-1	Cracked Corn
FED22-264-2	Soybean Meal
FED22-264-3	Soybeans
FED22-266	Poultry Feed
FED22-266-1	Cracked Corn
FED22-266-2	Soybean Meal
FED22-266-3	Soybeans
FED22-268	Bovine Feed
FED22-268-1	Cracked Corn
FED22-268-2	Soybean Meal
FED22-268-3	Soybeans
FED22-270	Pig Feed
FED22-270-1	Cracked Corn
FED22-270-2	Soybean Meal
FED22-270-3	Soybeans
FED22-296	Bovine Feed
FED22-296-1	Corn
FED23-01	Whole Corn
FED23-03	Soybean meal

Table 2. List of animal feeds tested for Aflatoxins B1, B2, G1, and G2 in the year 2022, continued.

Sample ID	Description
FED23-10	Whole Corn
FED23-12	Soybean Meal
FED23-013	Soybean Meal
FED23-014	Whole Corn
FED23-016	Cracked Corn
FED23-018	Soybeans

Table 3. List of animal feed samples tested for Fumonisin in 2022.

Sample ID	Description
FED23-01	Whole Corn
FED23-10	Whole Corn
FED23-014	Whole Corn
FED23-016	Cracked Corn

Table 4. List of animal feed samples tested for Deoxynivalenol in 2022.

Sample ID	Description	Amount Fount (ug/kg)
FED23-01	Whole Corn	<0.5
FED23-03	Soybean meal	1357
FED23-10	Whole Corn	<0.5
FED23-12	Soybean Meal	1308
FED23-013	Soybean Meal	1597
FED23-014	Whole Corn	1745
FED23-016	Cracked Corn	957
FED23-018	Soybeans	2470

Table 5. List of animal feeds tested for pesticides in the year 2022.

Sample ID	Description	Pesticide Found (mg/kg)
FED23-02	Whole Corn	<0.01
FED23-11	Whole Corn	<0.01
FED23-015	Whole Corn	<0.01
FED23-017	Cracked Corn	<0.01

Table 4. Results of animal feeds tested for toxic metals in the year 2022.

		Pb	Cd	As	Hg	Cu
Sample ID	**Description**			**ug/kg**		
FED23-019	Dog Feed	5.6	5.59	8.86	< 3.1	3589.09
FED23-021	Dog Feed	31.88	13.53	21.69	< 3.03	6422.79
FED23-023	Dog Feed	13.15	16.73	17.26	< 3.04	4022.61
FED23-025	Dog Feed	8.73	15.57	28.38	< 3.13	8474.54
FED23-027	Dog Feed	30.54	13.27	22.13	< 2.99	6556.66
FED23-029	Dog Feed	20.94	24.47	259.59	5.18	7499.52
FED23-031	Dog Feed	7.72	5.77	3.4	< 3.12	5463.81
FED23-033	Dog Feed	28.54	69.03	209.38	9.23	14761.68
FED23-035	Dog Feed	10.61	5.86	6.43	< 3.09	3681.97
FED23-037	Dog Feed	89.49	10.05	26.92	< 2.98	5538.58
FED23-043	Dog Feed	256.03	40.15	141.1	< 17.94	10957.4
FED23-045	Dog Feed	89.52	60.76	181.7	< 18.09	11679.16
FED23-047	Dog Feed	94.48	80.24	29.32	< 17.1	15033.12
FED23-049	Dog Feed	194.82	61.69	135.24	< 15.32	14275.53
FED23-051	Dog Feed	93.79	120.9	57.24	< 17.99	38776.99
FED23-053	Dog Feed	109.96	100.77	57.94	< 15.41	13927.62
FED23-055	Dog Feed	125.81	34.49	21.79	< 17.04	15765.15
FED23-057	Dog Feed	122.39	85.95	35.07	< 15.89	12764.18

Table 5. Results of animal feeds tested for macro minerals in the year 2022. Values in red indicate results that did not pass.

		Moisture	Ca	K	Mg	Na	P	S	Fe	Zn
Sample ID	**Description**				**%**				**mg/kg**	
FED22-138	Dog Feed	12	1.20	0.62	0.09	1.50	0.83	0.34		
FED22-141	Dog Feed	71	0.23	0.28	0.04	0.06	0.18	0.09	-	-
FED22-144	Dog Feed	75	0.78	0.30	0.03	0.33	0.47	0.12	-	-
FED22-147	Dog Feed	71	0.63	0.21	0.02	0.24	0.37	0.13	-	-
FED22-150	Dog Feed	76	0.49	0.23	0.03	0.20	0.33	0.16	-	-
FED22-153	Dog Feed	75	0.57	0.29	0.03	0.15	0.37	0.12	-	-
FED22-156	Dog Feed	73	0.50	0.29	0.03	0.22	0.34	0.16	-	-
FED22-159	Dog Feed	79	0.53	0.22	0.02	0.26	0.32	0.12	-	-
FED22-162	Dog Feed	75	0.39	0.23	0.04	0.11	0.25	0.12	-	-
FED22-165	Dog Feed	76	0.32	0.34	0.02	0.20	0.29	0.18	-	-
FED22-168	Dog Feed	73	0.36	0.31	0.03	0.17	0.29	0.13	-	-
FED22-171	Dog Feed	77	0.65	0.31	0.02	0.29	0.43	0.14	-	-
FED22-174	Dog Feed	69	0.37	0.37	0.05	0.10	0.23	0.11	-	-
FED22-177	Dog Feed	76	0.60	0.38	0.03	0.17	0.37	0.11	-	-
FED22-180	Dog Feed	6	2.26	1.07	0.20	0.45	1.37	0.44	-	-
FED22-183	Dog Feed	7	1.66	1.49	0.18	0.73	1.20	0.52	-	-
FED22-186	Dog Feed	6	1.52	0.76	0.14	0.37	1.10	0.72	-	-
FED22-189	Dog Feed	7	0.98	0.82	0.17	0.40	0.92	0.33	-	-
FED22-192	Dog Feed	8	2.32	0.93	0.21	0.39	1.42	0.41	-	-
FED22-205	Pig Feed	11	0.70	0.74	0.14	0.24	0.37	0.17	-	-
FED22-207	Sheep Feed	10	0.77	0.92	0.16	0.16	0.32	0.20	-	-

Table 5. Results of animal feeds tested for macro minerals in the year 2022, continued. Values in red indicate results that did not pass.

		Moisture	Ca	K	Mg	Na	P	S	Fe	Zn
Sample ID	**Description**				**%**				**mg/kg**	
FED22-209	Bovine Feed	7	2.85	1.53	0.89	1.02	0.81	0.53	-	-
FED22-211	Bovine Feed	9	1.84	1.10	0.35	0.74	0.40	0.26	-	-

FED22-233	Bovine Feed	10	1.61	1.20	0.37	0.51	0.59	0.30	-	-
FED22-235	Other Ruminant Feed	11	0.91	0.92	0.21	0.27	0.76	0.28	-	-
FED22-237	Sheep Feed	10	1.00	0.83	0.26	0.27	0.50	0.29	-	-
FED22-239	Pig Feed	10	1.02	1.05	0.25	0.23	0.65	0.29	-	-
FED22-241	Poultry Feed	10	1.73	1.01	0.19	0.23	0.55	0.25	-	-
FED22-243	Poultry Feed	10	1.16	0.90	0.18	0.16	0.49	0.22	-	-
FED22-245	Poultry Feed	11	1.40	0.91	0.18	0.17	0.48	0.22	-	-
FED22-247	Poultry Feed	10	1.80	0.83	0.20	0.22	0.55	0.22	-	-
FED22-249	Pig Feed	11	0.58	0.74	0.20	0.18	0.43	0.15	-	-
FED22-251	Poultry Feed	9	5.13	0.67	0.19	0.11	0.37	0.20	-	-
FED22-253	Poultry Feed	10	4.49	0.75	0.19	0.17	0.37	0.21	-	-
FED22-255	Pig Feed	11	0.76	0.86	0.26	0.22	0.40	0.18	-	-
FED22-257	Pig Feed	10	0.63	0.88	0.16	0.22	0.44	0.19	-	-
FED22-259	Bovine Feed	10	1.79	1.00	0.51	0.53	0.56	0.35	-	-
FED22-261	Pig Feed	10	0.69	0.82	0.16	0.22	0.45	0.18	-	-
FED22-263	Sheep Feed	10	1.01	1.02	0.19	0.19	0.42	0.20	-	-
FED22-265	Poultry Feed	10	0.72	1.16	0.21	0.12	0.60	0.25	-	-
FED22-267	Bovine Feed	11	0.51	1.15	0.36	0.62	0.63	0.24	-	-
FED22-269	Pig Feed	10	0.62	0.87	0.18	0.18	0.51	0.18	-	-
FED22-297	Bovine Feed	8	5.48	1.08	0.52	0.78	0.90	0.33	-	-
FED22-298	Poultry Feed	12	0.89	0.97	0.27	0.17	0.78	0.22	-	-
FED22-299	Poultry Feed	11	4.95	0.93	0.34	0.14	0.73	0.24	-	-
FED22-300	Poultry Feed	13	4.48	0.90	0.31	0.16	0.77	0.24	-	-
FED22-301	Poultry Feed	10	1.07	0.92	0.24	0.19	0.79	0.22	-	-

Table 5. Results of animal feeds tested for macro minerals in the year 2022, continued. Values in red indicate results that did not pass.

		Moisture	**Ca**	**K**	**Mg**	**Na**	**P**	**S**	**Fe**	**Zn**
Sample ID	**Description**	**%**							**mg/kg**	
FED22-302	Poultry Feed	13	1.24	1.09	0.28	0.03	0.64	0.24	-	-
FED22-303	Poultry Feed	11	1.19	1.26	0.27	0.16	0.68	0.25	-	-

FED22-304	Poultry Feed	11	4.52	0.90	0.31	0.15	0.78	0.24	-	-
FED22-305	Poultry Feed	10	1.58	1.39	0.27	0.20	0.82	0.33	-	-
FED22-306	Poultry Feed	11	0.92	1.02	0.22	0.14	0.67	0.35	-	-
FED22-307	Poultry Feed	11	1.06	1.09	0.28	0.13	0.63	0.24	-	-
FED22-308	Poultry Feed	10	3.72	0.91	0.29	0.18	0.66	0.22	-	-
FED22-309	Poultry Feed	11	4.75	0.79	0.27	0.18	0.66	0.28	-	-
FED23-04	Poultry Feed	10	4.35	0.67	0.18	0.14	0.36	0.18	120.96	28.54
FED23-06	Poultry Feed	10	1.35	1.09	0.22	0.27	0.56	0.27	157.25	52.48
FED23-08	Poultry Feed	10	1.48	0.85	0.18	0.26	0.52	0.22	148.10	53.68
FED23-019	Dog Feed	85	0.25	0.15	0.02	0.11	0.22	0.10	90.31	95.18
FED23-021	Dog Feed	75	0.64	0.33	0.02	0.25	0.43	0.14	95.29	104.23
FED23-023	Dog Feed	78	0.46	0.21	0.04	0.13	0.35	0.12	55.10	47.68
FED23-025	Dog Feed	72	0.63	0.33	0.03	0.12	0.41	0.14	74.51	53.25
FED23-027	Dog Feed	78	0.48	0.24	0.02	0.24	0.28	0.14	65.14	57.32
FED23-029	Dog Feed	77	0.36	0.41	0.05	0.12	0.27	0.12	79.64	76.42
FED23-031	Dog Feed	79	0.50	0.18	0.02	0.22	0.34	0.13	62.24	61.30
FED23-033	Dog Feed	70	0.36	0.35	0.03	0.40	0.35	0.13	74.65	80.51
FED23-035	Dog Feed	75	0.69	0.31	0.03	0.21	0.44	0.15	49.83	67.04
FED23-037	Dog Feed	75	0.50	0.28	0.03	0.11	0.37	0.12	124.88	49.54

Table 5. Results of animal feeds tested for macro minerals in the year 2022, continued. Values in red indicate results that did not pass.

		Moisture	Ca	K	Mg	Na	P	S	Fe	Zn
Sample ID	**Description**	**%**							**mg/kg**	
FED23-043	Dog Feed	5	1.94	0.77	0.11	0.55	1.06	0.47	241.71	188.87
FED23-045	Dog Feed	6	1.28	0.64	0.14	0.45	1.01	0.52	187.96	196.72
FED23-047	Dog Feed	5	1.85	0.68	0.14	0.36	1.23	0.49	187.46	121.32
FED23-049	Dog Feed	8	0.89	0.74	0.15	0.42	0.66	0.50	253.36	230.39
FED23-051	Dog Feed	5	0.79	0.88	0.20	0.22	1.02	0.40	242.80	71.59
FED23-053	Dog Feed	4	2.25	0.83	0.15	0.48	1.26	0.34	207.83	184.64
FED23-055	Dog Feed	7	1.56	0.79	0.11	0.40	1.09	0.33	168.50	184.07
FED23-057	Dog Feed	8	1.71	0.89	0.12	0.58	1.18	0.36	208.24	226.55

Table 6. Results of dog food tested for copper and moisture in the year 2022.

		Moisture	Cu
Sample ID	**Description**	**%**	**mg/kg**
FED22-139	Dog Feed	12	27
FED22-142	Dog Feed	71	5
FED22-145	Dog Feed	76	5
FED22-148	Dog Feed	77	6
FED22-151	Dog Feed	77	7
FED22-154	Dog Feed	74	7
FED22-157	Dog Feed	74	7
FED22-160	Dog Feed	79	7
FED22-163	Dog Feed	75	3
FED22-166	Dog Feed	76	7
FED22-169	Dog Feed	73	19
FED22-172	Dog Feed	76	34
FED22-175	Dog Feed	70	11
FED22-178	Dog Feed	76	7
FED22-181	Dog Feed	6	22
FED22-184	Dog Feed	7	19
FED22-187	Dog Feed	6	15
FED22-190	Dog Feed	7	13
FED22-193	Dog Feed	8	14
FED22-195	Dog Feed	84	4
FED22-197	Dog Feed	86	2
FED22-199	Dog Feed	72	3
FED22-201	Dog Feed	80	4
FED22-203	Dog Feed	5	50
FED22-204	Dog Feed	79	3
FED22-213	Dog Feed	74.7	7

Table 6. Results of dog food tested for copper and moisture in the year 2022, continued.

Sample ID	Description	Moisture %	Cu mg/kg
FED22-214	Dog Feed	74.8	5.8
FED22-215	Dog Feed	77.8	6.4
FED22-216	Dog Feed	78.1	4.7
FED22-217	Dog Feed	80.4	4.6
FED22-218	Dog Feed	80	7.8
FED22-219	Dog Feed	78.1	3
FED22-220	Dog Feed	76.2	5.9
FED22-221	Dog Feed	75.9	6.2
FED22-222	Dog Feed	80.9	5.4
FED22-223	Dog Feed	75.8	6.5
FED22-224	Dog Feed	75.2	9.5
FED22-225	Dog Feed	77	5.1
FED22-226	Dog Feed	77.1	19.9
FED22-227	Dog Feed	78.7	3.4
FED22-228	Dog Feed	75.5	6.1
FED22-229	Dog Feed	24	12
FED22-230	Dog Feed	7	13
FED22-231	Dog Feed	7	14
FED22-232	Dog Feed	6	14
FED22-271	Dog Feed	4	48
FED22-272	Dog Feed	6	19
FED22-273	Dog Feed	5	13
FED22-274	Dog Feed	4	12
FED22-275	Dog Feed	78	12
FED22-276	Dog Feed	79	4
FED22-277	Dog Feed	76	5

Table 6. Results of dog food tested for copper and moisture in the year 2022, continued.

		Moisture	Cu
Sample ID	**Description**	**%**	**mg/kg**
FED22-278	Dog Feed	79	6
FED22-279	Dog Feed	73	16
FED22-280	Dog Feed	75	6
FED22-281	Dog Feed	84	2
FED22-282	Dog Feed	82	3
FED22-283	Dog Feed	81	5
FED22-284	Dog Feed	74	7
FED22-285	Dog Feed	80	4
FED22-286	Dog Feed	76	4
FED22-287	Dog Feed	77	6
FED22-288	Dog Feed	78	7
FED22-289	Dog Feed	77	5
FED22-290	Dog Feed	73	28
FED22-291	Dog Feed	77	7
FED22-292	Dog Feed	69	6
FED22-293	Dog Feed	76	4
FED22-294	Dog Feed	82	3
FED22-295	Dog Feed	74	4

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